The Moderating Effect of Governance on the Trade Facilitation and Food Security Nexus in West Africa

Oluwanifemi Adeyemo[1], Njong Mom Aloysius (PhD)[2]

[1]Pan Africa University, Institute of Governance, Humanities and Social Sciences Soa, Cameroon

[2]Professor, Development Economics, The University of Bamenda, Faculty of Economics and Management Sciences,

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ABSTRACT

The study investigates the nexus between trade facilitation and food security relationship in West Africa, emphasizing the moderating role of governance. Utilizing a panel data approach, the analysis explores the impact of customs management on food security, considering business environment, information, and communication technology (ICT), and electricity as control variables. The findings reveal that efficient customs management significantly enhances food security, with governance playing a critical role in amplifying this effect. The study demonstrates that improved governance structures enhance the positive impact of cross-border trade facilitation on food security, leading to a 22% increase in customs management efficiency. Moreover, a conducive business environment, advancements in ICT, and reliable electricity infrastructure are shown to contribute positively to food security. The results underscore the importance of robust governance frameworks and infrastructural development in achieving sustainable food systems and food sufficiency in West Africa. By addressing the identified barriers, policymakers can create an enabling environment that supports agricultural productivity and ensures the equitable distribution of food resources across the region.

Keywords: Cross-border trade facilitation, Governance, food security, West Africa, Panel Data Analysis.

INTRODUCTION

Governance plays a pivotal role in trade facilitation by regulating interactions between states and stakeholders through both hard and soft instruments. Eivestad and Veggeland (2010) emphasize the importance of these governance modes, where soft instruments aim to eliminate red tape and bureaucratic bottlenecks across borders, while hard instruments enforce compliance with multilateral agreements, such as the WTO Trade Facilitation Agreement. Transparency is a critical aspect of governance, as highlighted by Weiss and Steiner (2006), to ensure the inclusive participation of parliaments, non-governmental organizations (NGOs), and the private sector in trade policy discussions.

Trade facilitation is increasingly recognized as a solution to food security challenges, particularly in addressing domestic food shortages and price volatility. The Global Monitoring Report (2012) by the World Bank argues that these issues often arise from the inability to move food efficiently from surplus to deficit regions due to infrastructural and logistical barriers. Addressing border administration inefficiencies and infrastructure gaps has been shown to significantly impact agricultural productivity and food availability. For example, the World Bank (2013) notes that improving logistics systems and eliminating redundant customs processes could yield income gains up to six times greater than removing all import tariffs.

Efficient trade facilitation, particularly for perishable agricultural goods, requires streamlined border procedures, effective logistics, and robust infrastructure. Torres et al. (2017) identify the facilitation of agricultural trade as a critical enabler of food security, given the perishability of many food items. Delays caused by inefficient

customs inspections, redundant checkpoints, and inadequate infrastructure often lead to significant food waste and revenue loss. As such, prioritizing the ease of doing business across borders is essential for ensuring reliable food supply chains (Ibrahim et al., 2022).

The World Trade Organization highlights that trade facilitation involves harmonizing and simplifying international trade procedures, particularly those related to the movement and clearance of goods (Petrovic and Bjelic, 2014). The gaps left by earlier agreements like GATT 1947, which primarily addressed tariff reduction, underscore the need for governance mechanisms that ensure smoother logistics and transparency in trade practices. Proposed reforms, such as the adoption of single-window systems, expedited goods clearance, and predictable fee structures, further emphasize the need for strong governance frameworks (Widdowson et al., 2019).

Governance in trade facilitation extends beyond logistics to include fostering international cooperation, reducing trade barriers, and ensuring efficient border management. Hira and Cohn (2003) argue that adherence to governance principles, such as eliminating corruption and promoting transparency, has a direct impact on trade facilitation. Countries adopting good governance indicators have successfully minimized trade obstacles, as seen in the establishment of one-stop border posts (OSBP) in East Africa, such as the Kenya-Uganda corridor (Nkundabaramye and Njong, 2021).

Moreover, trade openness has far-reaching implications for food security. Brooks and Matthews (2015) assert that open markets enhance food availability by moving goods from surplus to deficit areas and improving accessibility by increasing incomes through trade. Trade also diversifies national diets, contributing to better nutrition and utilization.

Governance, therefore, is not merely an enabler but a fundamental pillar of sustainable trade facilitation systems that underpin regional and global food security. However, the West African region suffers from governance challenges, including corruption, policy inconsistencies, and weak institutional capacity (Padonou et al., 2023). For instance, widespread bribery at customs checkpoints and roadblocks not only increases the cost of trade but also delays the movement of food products, exacerbating supply chain inefficiencies. Empirical evidence highlights those corrupt practices, coupled with inadequate enforcement of trade policies, undermine efforts to streamline cross-border trade and enhance food security.

For these reasons, this study examines the effect of governance on the trade facilitation and food security nexus in West Africa. The rest of the paper is organized as follows: Section 2 presents the conceptual framework, Section 3 reviews the empirical literature, Section 4 discusses the methodology, Section 5 presents the results and discussion, and Section 6 concludes with policy recommendations.

CONCEPTUAL LINKAGES

The conceptual framework of this study comprises a main independent variable (cross-border trade facilitation, proxied by customs management), a moderating variable (governance), three control variables (business environment, information and communication technology, and electricity), and the dependent variable (food security). These concepts are most latent and could only be assessed from secondary available variables, which were combined scientifically using the principal component analysis. The main relationships of interest in this study are those of the cross-border trade facilitation and governance with food security, while governance is simultaneously assessed for its role as a moderator (strengthening the impact of the main independent variable cross-border trade facilitation). These nexuses are considered in the presence of some control variables business environment, information and communication technology and electricity, which gives a picture of the workings of the systems and availability of basic infrastructure in these countries. Cross-border trade facilitation, if adequately administered, is expected to improve food security status of the citizens of the countries, given the plausibility of having variety of input options ranging from technological advancements and biochemical innovations for improved seedlings. Governance is also expected to directly influence the food security status of the populace and in addition play a moderating role on the impact of cross-border trade facilitation on food security.

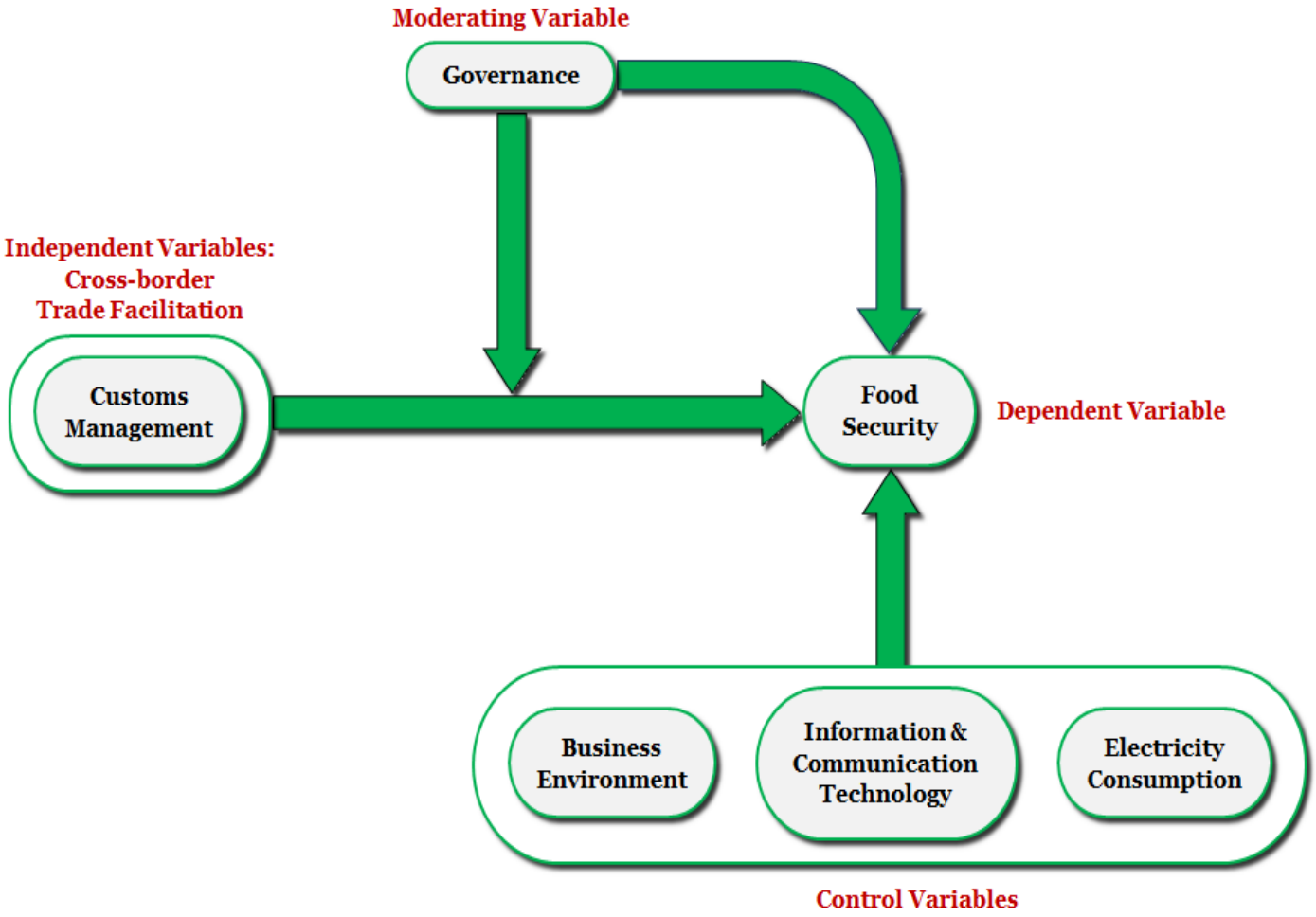

Figure 1: Conceptual Framework for this Study

Source: Authors, based on World bank, and AfDB data base.

LITERATURE REVIEW

The theoretical foundation linking cross-border trade facilitation, governance, and food security is rooted in stakeholder theory, introduced to management studies in the 1970s and later refined by Freeman in 1984. This theory broadens the scope of corporate accountability by engaging multiple actors such as government agencies, customs officials, businesses, and civil society organizations (Wheeler et al., 2002). Its relevance to trade facilitation lies in its emphasis on inclusivity, collaboration, and stakeholder participation, which fosters broader perspectives and ensures successful implementation of trade facilitation measures. Stakeholders like importers, exporters, and logistics providers directly benefit from faster customs processes, reduced paperwork, and lower transaction costs. However, balancing competing interests and addressing governance-related challenges remain critical issues in applying stakeholder theory to trade facilitation (Wheeler et al., 2002).

Malthus's population theory, first articulated in 1798, highlighted the potential challenges of population growth on food supply, emphasizing resource scarcity. However, critics have noted its simplistic view of human behavior and its failure to account for technological and institutional innovations that enhance resource management and sustainability (Sen, 1986; Tilman et al., 2019). While Malthusian concerns have shifted to regional contexts, his work underlines the persistent relevance of food security challenges, particularly in regions like West Africa where trade inefficiencies exacerbate food supply issues.

Adam Smith's theory of absolute advantage (1776) and David Ricardo's theory of comparative advantage (1821) provide foundational insights into international trade's benefits. Smith emphasized specialization's productivity gains, while Ricardo focused on opportunity costs and mutual economic prosperity through trade. However, these classical theories do not adequately address contemporary trade facilitation challenges such as customs

inefficiencies, infrastructure deficits, and governance-related barriers, which are particularly pronounced in developing regions like West Africa (Waton, 2017; Bellino & Fratini, 2019).

Existing studies highlight the multifaceted role of governance in trade facilitation and its implications for food security. Margulis (2017) discusses global governance in food security, emphasizing harmonization of customs policies and agricultural trade integration. However, inter-organizational rivalry due to differing mandates and policy paradigms among international organizations remains a challenge. Kumari & Bhart (2021) find that high-quality governance accelerates trade facilitation by reducing bureaucratic inefficiencies, while weak governance hinders procedural clarity and resource allocation. Lloyd-Ellis et al. (2021) corroborates the positive impact of trade facilitation on food security, particularly through increased food availability via imports.

Regional studies provide further insights into governance dynamics. Asare Nuamah et al. (2021) explore how political, economic, and institutional governance dimensions improve food security in Ghana by promoting transparency, accountability, and effective policy implementation. Adekoya & Ayuba (2019) emphasize economic growth and agricultural production's roles in reducing food insecurity, while Matthew et al. (2019) highlights agriculture's poverty reduction potential through value-added contributions. Osabohien et al. (2021) underscore the significance of an enabling governance environment in enhancing agricultural production and food security within the ECOWAS region.

Despite these contributions, a notable gap exists in the literature regarding the moderating role of governance in the trade facilitation–food security nexus in West Africa. While studies have examined trade facilitation's direct impact on food security and governance's role in enhancing trade efficiency, few have explicitly analyzed how governance moderates this relationship.

Methodologically, previous studies have employed qualitative methods to carry out research using models such Systems Generalized Method of Moments (SGMM), and panel static analysis using Panel Corrected Standard Error (PCSE) among others. It is based on this purpose that the study employed the panel generalized least squares (PGLS) estimation method because it accounts for possible presence of AR (1) autocorrelation within panels, cross-sectional dependence among cross-sectional units. The study provided depth of analysis by employing a robust data composition to build index for the dependent and independent variables using the principal component analysis (PCA). To capture the four dimension of food security including availability, accessibility, utilization and stability, the study developed a food security index. This study seeks to address this gap by investigating the moderating effect of governance on the nexus between trade facilitation and food security in West Africa.

METHODOLOGY

This study utilizes several key datasets to ensure a comprehensive analysis of the variables under investigation. Trade facilitation is assessed using the World Bank's Doing Business dataset, particularly focusing on the Trade facilitation variables. Governance data is obtained from the World Bank's Worldwide Governance Indicators (WGI), which provide a robust framework for analyzing six critical dimensions of governance: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. To account for control variables, the study incorporates data from the African Development Bank (AfDB) dataset, which includes indices such as the Business environment, advancements in information and communication technology (ICT), regular electricity supply, and the Water Supply and Sanitation (WSS) Composite Index. These variables provide additional layers of analysis to capture the broader context of the study. To measure food security, the study relies on data from the Food and Agricultural Organization (FAO), which conceptualizes food security through four key pillars: availability, accessibility, utilization, and stability.

The analytical framework linking cross-border trade facilitation and food security presents a somewhat complex relationship. Given the state of global food insecurity, robust bilateral trade agreements become essential to accelerate the seamless flow of goods and services amongst countries and incentivize key sector stakeholders to contribute to taming hunger, malnutrition and global food insecurity (Hansen-Addy et al, 2024). Cross-border trade facilitation enhances open trade model, which increases agricultural production in a way that accelerates food supply and induces lower prices. The open trade policy facilitates the spread of high-yield, high-input

agriculture and reduces the logistics rigidities in cross-border food distribution value chain. The governance of cross-border management and trade facilitation process thus, increases the accessibility, availability and affordability of refined carbohydrates and staple such as wheat, rice, sugar, etc. with potentials to engender food security (Herbert, 2022).

Empirically, an assessment of the relationship of cross-border trade facilitation and food security in the literature literature was based on several estimation models that employed cross-sectional data, time series data and panel data. These methodologies included descriptive approach or econometrics approach that leverages the different data sets. For a multi-country analysis, a panel data-based analysis is often adopted. Some of the panel data estimation approaches included the Panel Corrected Standard Error (PCSE) technique (Adekayo & Ayuba, 2019; Aderunmu, 2022), and Generalized Method of Moments (GMM) modelling and Systems Generalized Method of Moments (SGMM) and Panel Generalized Least Squares (Padonou et al, 2023).

This study adopts the panel generalized least squares (PGLS) as the estimation method due to the nature of existing relationship among the variables of interest. The choice of the panel generalized least squares method is premised on the merit that it accounts for possible presence of $AR(1)$ autocorrelation within panels, cross-sectional correlation (dependence) and heteroskedasticity across cross-sectional units (countries). As a precursor to the estimation of the nexus between trade facilitation (customs management) and food security, we control for business environment, information and communication technology as well as access to electricity. The model specification for the static panel is given by Equation (3.1) as:

$$FS_{it} = \gamma_0 + \gamma_1 CM_{it} + +\gamma_2 BE_{it} + \gamma_3 ICT_{it} + \gamma_4 \Delta ICT_{it} + \gamma_5 ECI_{it} + \gamma_6 \Delta ECI_{it} + \epsilon_{it} \qquad (3.1)$$

where $i = 1, \dots, m$ is the number of cross-sectional units (or countries) and $t = 1, \dots, T$ is the number of observations for panel i; FS_{it} is the food security index for country i at time t; CM_{it} is the customs management index for country i at time t; BE_{it} is the business environment index for country i at time t; ICT_{it} is the information and communication level for country i at time t; ECI_{it} is the electricity composite index for country i at time t; while ϵ_{it} is the model disturbance term.

The terms, ΔICT_{it} and ΔECI_{it} are the first differences of the information and communication technology index and the electricity composite index, respectively, which are incorporated to account for the evidenced unit root that characterized the information and communication technology index and the electricity composite index. The nature of the variables developed for this study is here briefly presented, by way of pre-description. The lower and upper extremes of the food security index denote lower and higher levels of food security. However, for the customs management index, the lower the index value, the better the management system of the customs services. Essentially, this is so given that the index captures how fast cross-border activities are carried out, such that lower index values imply that services are rendered within the shortest possible time, while higher value indicated that a longer time period is required. From the above descriptions, the a priori expectation for the slope coefficients are as follows: $\gamma_2,\ \gamma_3,\ \gamma_5 \geq 0$ (positive nexus with food security); $\gamma_1 \leq 0$ (negative nexus with food security).

RESULTS AND DISCUSSION

Table 1 presents the estimation results of the cross-border trade facilitation – food security nexus; while controlling for business environment, information and communication technology, and electricity.

Table 1: Summary Statistics

Variable	Food Security	Business Environment	Customs Management	Electricity Consumption Index	Information and Communication Technology
Mean	3.51E-09	1.44E-08	-1.8E-08	2.96	4.78
Std. Dev.	1.36	1.33	2.30	3.65	6.51

Minimum	-2.66	-2.89	-2.94	-3.19	-6.81
Maximum	3.98	4.46	8.98	25.51	28.02
Skewness	0.78	1.38	2.73	2.48	1.34
Kurtosis	3.58	5.11	9.96	13.02	4.31
Jarque-Bera	33.18***	143.07***	929.18***	1484.68***	105.85***
Number of observations	285	285	285	285	285

Source: Authors, based on World bank, and AfDB data base

Note: The table presents the descriptive statistics of the variables employed in this study. The Jarque-Bera Statistic shows whether the variable is normally distributed. The null hypothesis asserts that the variable is normally distributed, against an alternative that it is not. The *** indicate statistical significance of the test at 1% level. Statistical significance implies rejection of the null hypothesis.

The estimated slope coefficient associated with customs management is significantly negative at 1% level of significance. The implication here is that better customs management (lower index) tends to improve food security status of the selected West African countries. In terms of magnitude, improvements in customs management contributed about 9.6 percent decrease in food insecurity in West Africa during the study period. Intuitively, when the customs management practice of cross-border and related activities are efficiently handled, the trading and documentation are done seamlessly and timely; and this translates to timely delivery of inputs and sales of outputs across the borders; thereby, improving productivity and subsequently, food security.

Simultaneously, improved business environment, advances in ICT and adequate electricity supply also facilitate food security in the selected West African countries for the study period, as their associated coefficients are positive and statistically significant at 1% level of significance. In terms of magnitude, the coefficients show that business environment, ICT and electricity simultaneously contributed about 21.40%, 6.7% and 0.2% reduction in food security in the selected West African countries during the study period. These control variables stances lay emphasis on the importance of adequate infrastructural development to enhancing food security.

Cross-Border Trade Facilitation - Food Security Nexus and the Moderating Role of Governance

Table 2 presents the estimation results based on the model specification in Equation (3.1) that addresses the hypothesis on the cross-border trade facilitation food security nexus and the moderating role of governance; while still controlling for business environment, information and communication technology, and electricity.

Table 2: Empirical Results

VARIABLES	**Coefficient (Standard Error)**
Customs Management	-0.1180*** (0.0025)
Governance	0.1040*** (0.0249)
Business Environment	0.2320*** (0.0065)
Information and Communication Technology	0.0600*** (0.0011)
Δ(Information and Communication Technology)	-0.0109*** (0.0020)
Electricity	0.2010*** (0.0027)
Δ(Electricity)	-0.1200*** (0.0066)

Customs Management ∗ Governance	-0.0337*** (0.0017)
Constant	-0.8830*** (0.0098)

Source: Authors, based on World bank, and AfDB data base; Note: The figures in each cell are the coefficient estimates with their corresponding standard errors in parentheses and statistical significance at 1%, 5% and 10% levels denoted by ***, ** and *, respectively.

The estimated slope coefficient associated with cross-border trade facilitation (proxied by customs management) is significantly negative at 1% level of significance. The negative associated coefficient implies that better customs management (lower index) tends to improve food security status of the selected West African countries being studied. Intuitively, when the customs management practice of cross-border and related activities are efficiently handled, the trading and documentation are done seamlessly and timely; and this translates to timely delivery of inputs and sales of outputs across the borders; thereby, improving productivity and subsequently, food security.

The coefficient of governance is positive and statistically significant at 1% level, indicating the improved governance structure enhances food security. Additionally, governance moderates the impact of customs management upwards, given the negative coefficient estimates of the interaction term in a similitude in terms of sign of the coefficient estimate associated with customs management. Imperatively, governance structure further enhances the status of food security of the countries being studied. Business environment, advances in ICT and electricity maintain their positive sign and significance in predicting food security, while the magnitude slightly varied. Again, it can be concluded that adequate cross-border trade facilitation, with infrastructural development, ensures food security.

The study investigates the effect of the moderating role of governance on cross-border trade facilitation and food security nexus. This was to assess whether the governance structure in West African countries moderates the impact of cross-border trade facilitation on food security, either positively or negatively. Findings from empirical studies showed that better customs management significantly improved food security in West African countries. Efficient trading activities, such as seamless and timely documentation processes, translate into timely delivery of agricultural products and allied inputs, as well as sales of outputs across borders. This improves the productivity of trading activities and, consequently, food security.

The moderating role of governance enhanced the effects of cross-border trade facilitation on food security in West Africa. This result implies that for West Africa to achieve food sufficiency, cross-border trade must be accompanied by a good governance structure to amplify its effects on food security in the continent. A robust governance structure is crucial for building an agricultural value chain and sustainable food systems that underpin the achievement of food sufficiency. This would further influence various aspects of food security, such as availability, accessibility, and affordability. In essence, these recent studies underscore the critical role of good governance in amplifying the food security benefits of increased regional trade integration in West Africa. By establishing the necessary institutional, regulatory, and organizational structures, policymakers can create an enabling environment that empowers smallholder farmers, streamlines food supply chains, and ensures the equitable distribution of food resources across the region, ultimately contributing to the achievement of food sufficiency.

This finding is supported by Akinola et al. (2023), who examined the role of governance quality in moderating the relationship between regional trade integration and food security in West Africa. The results showed that strong governance institutions, characterized by factors like political stability, government effectiveness, and regulatory quality, are crucial for translating the benefits of increased cross-border trade into tangible improvements in food availability, accessibility, and affordability. Similarly, the West African Food Security Commission Report (2024) highlighted that while infrastructure development and trade facilitation are important, they must be accompanied by complementary efforts to strengthen agricultural value chains and build sustainable food systems. This requires robust governance frameworks that can ensure transparent regulations, efficient public services, and effective coordination among various stakeholders along the food supply chain.

Ogunleye et al. (2024) showed that countries in West Africa with more developed governance structures, such as clear land tenure policies, effective extension services, and inclusive decision-making processes, were better able to leverage cross-border trade to boost domestic agricultural productivity, reduce post-harvest losses, and improve food distribution networks. This finding is similar to Moraa & Nekesa (2023), who investigated the effect of governance on various aspects of food security in Africa and found that country-specific characteristics in terms of the rule of law, voice and accountability, and other measures of governance affect food security outcomes.

As opined by Herbert (2022), Cheruiyot & Rotich (2018), food security in West Africa needs to be situatedwithin the context of governance structures, which would amplify policies and remove any bottlenecks that may hinder transactional activities underlying most distributive trades in the continent. It also constrains the proliferation of illegal entrepreneurs and business-as-usual behaviors, which may not reflect true opportunity costs, particularly in the distribution of food or enforcing contracts.

Similarly, the controlled effects of business environment, information and communication technology (ICT), and electricity components to assess the linkage among cross-border trade facilitation, governance, and food security in the selected countries. Findings showed that food security in West Africa could be achieved faster in a conducive business environment. This is plausible because a constructive environment improves the ease of doing business, promoting entrepreneurship. In addition, development can be fast-tracked through equality and justice for innovation and entrepreneurship, creating a constructive environment that eases business activities within the value chain involved in agricultural production and food distribution.

Corroborating this, Byers & Woolfrey (2022) found that infrastructural development could significantly enhance agricultural productivity and improve food security outcomes. The study indicated that investments in transportation networks, irrigation systems, storage facilities, and other agricultural infrastructure could improve farmers' access to markets, inputs, and technologies. This, in turn, boosts crop yields, reduces post-harvest losses, and stabilizes food prices. The study highlights that the benefits of agricultural infrastructure extend beyond productivity gains, as improved infrastructure also promotes greater integration of local and regional food markets. This strengthens food supply chains, increases the diversity of available food sources, and ultimately enhances the affordability and accessibility of nutritious foods for consumers across the African continent.

From the agricultural value chain perspectives, access to valuable inputs would enhance the level of agricultural output. Open border trade facilitation is expected to increase the availability of inputs, whether machinery or improved seedlings, which can enhance domestic food production. However, this has to pass through the process of exchange, which depends on the business environment (Falchetta et al., 2021; Mohammed & Bunyaminu, 2021; Ibrahim et al., 2023; Hansen-Addy et al., 2024).

Sénquiz-Díaz (2021) quipped that transport and logistics were the major factors hindering trade facilitation, especially as it related to food security in West Africa. Salawu & Ghadiri (2022) emphasized that trade logistics bottlenecks such as inadequate seamless documentation limit the efficiency of the distribution value chain of agricultural products. However, the findings of Hansen-Addy et al. (2024) showed that tax administration and business licensing and registration regulations improved West African Small and Medium Enterprise (SME) performance, but these had negative effects on the performance of cross-border trade facilitation. The study found that ICT and adequate electricity were necessary for reducing food insecurity in West African countries, as shown by their coefficients. This result showed that existing ICT and electricity infrastructures at the borders facilitate cross-border trade, especially in the registration of consignments, documentation processes, exports and imports analysis, and seamless operations at the border in West African countries. However, the magnitude of the contribution of these variables shows that there is a need for more investments in infrastructure in customs management-related activities to increase efficiency and accelerate the rate at which cross-border trade enhances the distribution of agricultural inputs, thereby enhancing food security (Hansen-Addy et al., 2024).

This result corroborates Mohammed & Bunyaminu (2021), who argued that access to electricity, access to land, customs and trade regulations, and tax rates were the major obstacles affecting agribusiness in Ghana. Additionally, Osabuohien et al. (2019) and Hamadjoda (2024) asserted that infrastructural deficits and low levels of industrialization in almost all ECOWAS countries negatively affected regional trade by reducing regional

trade diversification capabilities in agricultural production.

Ibrahim et al. (2022) conducted a study examining the impact of key trade-enabling infrastructure, including telecommunications, transportation, and port facilities, on trade facilitation in Africa. Their findings suggest that the development of such infrastructure has a significant and positive influence on trade facilitation in the region. Improved trade facilitation, in turn, can enhance food security by facilitating the efficient movement of agricultural goods across borders, stabilizing prices, and ensuring better access to diverse food sources for consumers. The authors emphasize that targeted investment in trade-related infrastructure is crucial for unlocking the potential of cross-border trade to support food security outcomes across the African continent. Their study underscores the importance of adopting holistic approaches to strengthening regional economic integration and improving livelihoods through sustainable development.

The study by Shinyekwa & Ntale (2017) provides an interesting contrast and perspective on the role of different types of infrastructure in supporting cross-border trade and economic integration in Africa. They noted that hard or physical infrastructure (e.g., transportation, telecommunications, ports, etc.) has more potential to generate a greater impact on manufactured exports compared to soft infrastructure, suggesting that investments in hard physical infrastructure may be more impactful for boosting cross-border trade of manufactured goods across African countries. Thus, improved cross-border trade of food and agricultural goods, enabled by hard infrastructure, can, in turn, enhance food security by stabilizing prices, increasing access to diverse food sources, and improving the efficiency of food distribution.

Studies further noted that good digital documentation would remove unnecessary duplication of clearance procedures, increasing cooperation, sharing of information and trade data, and enabling better resource utilization (Cheruiyot & Rotich, 2018; Misati et al., 2021; Sidy & Cissokho, 2022). Essentially, the study posited that investment in infrastructural facilities, including roads, communications, and regular electricity, reduces trade costs and increases international trade networks. Additionally, infrastructural development can significantly raise agricultural productivity and boost food security (Byers & Woolfrey, 2022).

Confirming the interaction of governance and information and communication technologies (ICT) adoption on food security, Anser et al. (2021) noted that governance quality plays a crucial role in mediating the relationship between ICT adoption and food security. Countries with stronger governance institutions, characterized by factors like political stability, government effectiveness, and regulatory quality, are better able to leverage ICT to enhance food security. Furthermore, the study opined that ICT adoption alone is not sufficient to improve food security. The full benefits of ICT, such as improved access to market information, precision farming techniques, and supply chain optimization, become realistic when supported by a conducive governance environment.

Additionally, the interactive effect of governance and ICT is significant for improving the availability and accessibility dimensions of food security. ICT can enhance agricultural productivity and food distribution, but good governance should ensure these benefits are equitably distributed. The study concluded that investments in ICT infrastructure and governance reforms are complementary and necessary to achieve sustainable improvements in national and regional food security across developing countries, including sub-Saharan Africa.

CONCLUSION

The study concludes that cross-border trade facilitation, particularly through efficient customs management, is essential for improving food security in West Africa. Effective customs operations ensure the timely delivery of agricultural inputs and outputs, enhancing agricultural productivity and strengthening food systems. Governance plays a pivotal role in customs efficiency, with evidence showing that improved customs management can boost food security outcomes by 22%. Beyond customs, factors such as the business environment, ICT, and electricity infrastructure also significantly influence trade efficiency and food distribution. These interconnected elements highlight the need for a coordinated and sustainable approach to addressing food security challenges across the region.

The study’s findings call for actionable policy interventions. First, the implementation of governance

frameworks such as the African Continental Free Trade Area (AfCFTA) must go beyond harmonizing trade policies to include capacity-building initiatives, robust monitoring mechanisms, and regional data-sharing platforms to ensure compliance and accountability. Efforts to combat corruption among border officials should focus on leveraging technology, such as e-governance tools, to enhance transparency and streamline customs processes. Investment in infrastructure, including ports, seaways, and railways, must be accompanied by strategies to ensure long-term sustainability, particularly in the electricity sector, which underpins ICT systems and trade operations.

Adopting the Coordinated Border Management (CBM) approach is critical for enhancing customs efficiency. This approach should involve joint control posts, harmonized procedures, and bilateral agreements tailored to the specific needs of West African nations. Lessons from successful CBM implementations in regions like Central Asia and the East African Community (EAC) provide valuable insights, but these must be adapted to the region's unique political and socio-economic context. For example, investing in joint control posts at high-traffic borders and implementing Single Window platforms can streamline customs operations while fostering inter-agency collaboration.

The study emphasizes the importance of political stability and security for achieving sustainable food systems. Challenges such as terrorism, banditry, and political unrest, which disrupt agricultural production and distribution in countries like Burkina Faso, Mali, Niger, and Nigeria, require coordinated regional efforts. These include strengthening local governance structures, fostering dialogue to address conflict drivers, and enhancing community resilience to insecurity.

To address climate change and its impacts on agriculture, smart agricultural policies must incorporate advanced technologies for monitoring crop yields, mitigating risks, and optimizing food storage. Establishing food processing and storage facilities at strategic locations can help stabilize supply chains and buffer against seasonal fluctuations.

A comprehensive and inclusive approach is essential for achieving sustainable food security in West Africa. This includes transparent enforcement of trade policies, institutional reforms to improve efficiency, and active engagement of stakeholders, including private sector actors and local communities. By integrating these strategies, West African nations can build resilient food systems that ensure the availability, accessibility, and affordability of food, fostering long-term stability and prosperity across the region.

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APPENDIX

Table A1 Cross-sectional Dependence Tests

Variable	Food Security	Business Environment	Customs Management	Electricity Consumption Index	Governance Index	Information & Communication Technology
Breusch-Pagan LM	1163.16***	614.13***	765.74***	912.77***	487.72***	1084.62***
Pesaran scaled LM	73.02***	35.13***	45.60***	55.74***	26.41***	67.60***
Bias-corrected scaled LM	72.60***	34.72***	45.18***	55.32***	25.99***	67.18***
Pesaran CD	25.99***	10.66***	-1.93*	29.10***	1.35	31.06***

Source: Authors, based on World bank, and AfDB data base

Note: The table presents the cross-sectional dependence test for the variables employed in this study. The tests were conducted at the standard levels of significance, with ***, ** and * indicating statistical significance of the test at 1%, 5% and 10%, respectively. The null hypothesis asserts that there is cross-sectional independence against the alternative of evidence of cross-sectional dependence

Table A1 presents the results of the cross-sectional dependence (CSD) test, which asserts whether the cross sections are independent, or they have some dependencies. The null hypothesis here is that there is cross-section independence as against the alternative of cross-section dependence. Statistical significance of the test will connote the rejection of the null hypothesis at the stated conventional level(s) of significance. Again, a battery of tests is considered for robustness in the decision on the stance for each of the employed series. From the results presented in Table A1, all the tests (Breusch-Pagan LM, Pesaran scaled LM, Bias-corrected scaled LM, and Pesaran CD) are in strong agreement that there is evidence of cross-section dependence, and much so, mostly at 1% significance level. This suggest that the adopted model must account for the cross-section dependence to avoid biased parameter estimates.

Table 2: Multicollinearity Test Result

Variable	Variance Inflation Factor
Business Environment	1.12
Customs Management	1.13
Electricity	1.64
Governance	1.58
Information and Communication Technology	1.23

Source: Authors, based on World bank, and AfDB data base

Note: The table presents the variance inflation factor statistic for the employed variables in this study, which gives a measure of the presence, or otherwise, of multicollinearity. The test threshold is the value 10, where values less than 10 denote the absence of multicollinearity, while values from the threshold upwards indicate the presence of multicollinearity.

Table A2 displays the outcomes of the multicollinearity examination performed on the variables considered in this study, using the variance inflation factor (VIF). Traditionally, multicollinearity assessment relies on a VIF threshold of 10; VIF values below 10 indicate no significant multicollinearity, while values of 10 or higher suggest its presence.

Table A3: Panel Cross-Section and Period Heteroscedasticity Likelihood Ratio Test

Variable	**Likelihood Ratio Statistic**	
	Cross-section	**Period**
Food Security	241.6369***	222.9856***
Business Environment	374.6463***	374.6998***
Customs Management	316.5514***	808.1769***
Electricity	572.6761***	441.6370***
Governance	32.3493***	79.1060***
Information and Communication Technology	279.2977***	914.0769***

Source: Authors, based on World bank, and AfDB data base

Note: The table presents the panel heteroscedasticity likelihood ratio test statistic for the employed variables in this study, which gives a measure of the presence, or otherwise, of heteroscedasticity. The test null hypothesis assert that the series are homoscedastic against an alternative that the series are heteroscedastic. Statistical significance of the test at 1% level of significance is indicated by ***.

Table A3 presents the results of the panel cross-section (countries) and period (years) heteroscedasticity likelihood ratio test conducted on the variables under examination in this study. This test assesses the presence of heteroscedasticity across both cross-section (countries) and period (years) at standard levels of statistical significance. The null hypothesis posits the absence of heteroscedasticity in either cross-sections (countries) or periods (years). In Table A3, all likelihood ratio statistics are statistically significant at the 1% significance level, indicating strong evidence of heteroscedasticity in both cross-sections (countries) and periods (years). Consequently, the panel model framework employed must adequately address this observed heteroscedasticity to prevent biased results and/or parameter estimates.